UPPER OCEAN MIXING

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LONG-TERM GOAL

My long-term goal is to identify, quantify, and parameterize the major mixing processes in the upper ocean.

OBJECTIVES

My scientific objectives are to measure mixing directly with microstructure sensors and to relate these measurements to the larger scales producing the mixing in such a way that the results can be compared with either the large-scale changes resulting from the mixing or with theoretical predictions of mixing rates. My technological objectives are to develop instruments and sensors to measure the major mixing parameters.

APPROACH

Because a first-order understanding of mixing in the open ocean is rapidly being developed, our approach has shifted to obtaining a similar understanding of mixing near coasts and in estuaries. Because dissipation rates are higher in these waters, we have also shifted our technological developments to improve the spatial resolution of microstructure sensors and to adapt open-ocean measurements of finescale velocity to shallow water.

WORK COMPLETED

In May and April 1997 we participated in the Coastal Mixing and Optics field program on the New England continental shelf. In August 1997 we observed shear and mixing over the narrow continental shelf and slope off Monterey, California as part of the Littoral Internal Waves Initiative. Both cruises were successful and sampled markedly different mixing regimes.

We finished and are writing up one phase of the analysis of our observations of flow and mixing in Knight Inlet, B.C. with a study of the three-dimensional flow field.

Analysis of observations taken in the Bosphorus is nearing completion. Gregg traveled to Turkey to work with colleagues at the Middle East Technical University, both to understand particulars of the observations and to put them into the context of earlier work in the Strait. Understanding how the flow is controlled is proving difficult owing to the complicated bathymetry of the Bosphorus and to the shallowness of surface currents in the southern end of the Strait.

RESULTS

Flows over sills often limit water exchanges between inland seas and estuaries with the open ocean. Previous studies have assumed that the flows are two-dimensional, but in Knight Inlet we find that cross-channel flows and variability are important and must be considered to understand the flow adequately. To our knowledge, this is the first observation of this type of recirculation over sills in channels.

When water is strongly stratified over the New England shelf, internal solibores generated at the shelf break by tidal currents propogate shoreward every tidal cycle. At the CMO site the solibores depress the thermocline, which slowly recovers to its original position. Superimposed on this structure are much more rapid oscillations resulting from the solitary wave packet evolving within the solibore. Background mixing rates are very low between solibores but increase at least 50-fold during the early stages of the solibore. Consequently, most of the mixing occurs while the solibores are transiting

IMPACT/APPLICATION

Owing to its simple geometry, Knight Inlet was more likely to be dominated by the along-channel flow than many other sites where two-dimensional regimes are assumed. Demonstration of the importance of the three-dimensional circulation in Knight Inlet will lead to three-dimensional studies in many other flow regimes influenced by topography.

TRANSITIONS

The identification of solibores as major mixing agents on continental shelves demonstrates that existing parameterizations of mixing on shelves are improperly formulated and should lead to improved parameterizations.

Instruments developed with ONR-core and CMO funding were used during the LIWI work as well as during a study of mixing in Monterey Canyon funded by NSF.

RELATED PROJECTS

- Shear and Mixing in Monterey Canyon, with Eric Kunze and Leslie Rosenfield and funded by NSF.

- Development of a thinistor for measuring temperature microstructure, proposed to NSF with Professsor Fumio Ohuchi (University of Washington) based on preliminary work funded by ONR.

- Observations of intense mixing in the Banda Sea, proposed to NSF to use instruments developed with ONR funding.